English Translation of

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference: P023003-PCT

For further action:

See Notification of Transmittal of International Preliminary Examination Report

(From PCT/IPEA/416)

International application No.: PCT/JP03/12675

International filing date (day/month/year):

02 October 2003 (02.10/2003)

Priority date (day/month/year):

07 October 2002 (07.10.2002)

International Patent Classification(IPC) or national classification and IPC: H03M13/25, H04L27/18

Applicant: YOKOHAMA TLO COMPANY, Ltd.

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of __4__ sheets, including this cover sheet.

3. This REPORT is also accompanied by following ANNEXES.

a. x These annexes consist of a total of __4__ sheets.

x The Description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

4. This report contains indications relating to the following items:

I. x Basis of the report

V. x Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

VI. x Certain documents cited

Date of submission of the demand: 04 August 2004(04.08.2004)
Date of completion of this report: 28September 2004(28.09.2004)

International Preliminary Examination Report

International application No.
PCT/JP03/12675

I. Basis of the report

1. (Omitted)

2. This report has been drawn on the basis of the following documents. Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments.

x specification:

- pages 1-24, originally filed,

x claims:

- claims Nos. 8-10, 16, originally filed,
- claim Nos. 1-7, 11-15, 17, 18, amended under Article 19

x drawings:

- Figs. 1-12, originally filed.

3. (Omitted)

4. (Omitted)

V. Reasoned statement under Article 35 (2) with respect to novelty, inventive step or industrial applicability; citations and explanations supporting such statement:

1. STATEMENT:

Novelty (N)	Claims 1-18	YES
Inventive step (IS)	Claims 1-18	YES
Industrial Applicability(IA)	Claims 1-18	YES

2. CITATIONS AND EXPLANATIONS (PCT Rule 70.7):

Document 1: JP, 2000-196690 A (TOSHIBA TEC CORPORATION) 2000.07.14

Processes of multivaluing and encoding a binary digital information signal to a ternary signal of claims 1 through 18 are not disclosed in document 1 cited International Search Report, and are not obvious to a person having ordinary skill in the art.

VII. Certain documents cited

1. Certain documents published (PCT Rule 70.10)

Japanese publication No. 2003-209493

Publication Date: July 25, 2003(25.07.2003)

Application Date: January 11, 2002(11.01.2002)

Priority Date: January 11, 2002(11.01.2002)

Japanese patent Publication No. 2003-143249

Publication Date: May 16, 2003(16.05.2003)

Application Date: November 06, 2001(06.11.2001)

Priority Date: November 06, 2001(06.11.2001)

2. (Omitted)

05.03.04

World Intellectual Property Organization
PCT Division
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Amendment of the claims under Article 19(1)(Rule 46)

International Application No. : PCT/JP03/12675
International Filing Date : 02.10.03
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Applicant's or Agent's File reference : P023003-PCT

Dear sir
The Applicant, who received the International Search relating to the above identified International Application transmitted on 02.10.03, hereby files amendment under Article 19(1) as in the attached sheets.

Thus claims 1-7, 11-15, 17-18 are amended, and claims 8-10, 16 are retained unchanged.

The Applicant also files as attached herewith a brief statement explaining the amendment and indicating any impact that amendment therein might have on the description and drawings.

Very truly yours,

Akio Shionoiri

Attachment :

(1) Amendment under Article 19(1)	3 sheets
(2) Brief Statement	1 sheet

Explanation Based on Article 19 of the Patent Cooperation Treaty

Claims 1 through 7, 11 through 13, 17 and 18 make it clear that the two processes of multivaluing and encoding a binary digital information signal are carried out via a single constitution, simultaneously producing a ternary signal.

Furthermore, these amendments are based on the disclosures of lines 24 through 26 on Page 10, lines 11 through 22 on Page 14, lines 11 through 18 on Page 15, and lines 12 through 24 on Page 16.

In Cited Literature 1 (JP2003-209493) (NEC Corporation), which, of the literature cited, is considered to be especially relevant, the point that a binary is made into a multiary by performing data conversion, and this multiary is three-phase modulated is disclosed in Fig. 2, and the point that a binary is made into a ternary by performing data conversion, this ternary is made into an encoded ternary by ternary error correction encoding, and this encoded ternary is three-phase modulated, is disclosed in Fig. 5.

Further, in Cited Literature 2 (JP2003-142349) (NEC Corporation), for conventional technology, the point is disclosed that a binary is made into an encoded binary by binary error correction encoding, this encoded binary is made into an encoded multiary in accordance with binary-multiary conversion, and this encoded multiary is multiary modulated, and for the present invention, the point is disclosed that a binary is made into a multiary by binary-multiary conversion,

this multiary is made into an encoded multiary in accordance with non-secondary error correction encoding, and this encoded multiary is multiary modulated.

The points disclosed in these Cited Literatures indicate that the two process of multivaluing and encoding, respectively, are carried out independently, and that two-step processing is required to achieve an encoded multiary. Then, the problem with this binary-multiary conversion is that when n-number of binary signals are converted to p-number of multiary signals, because there is room for signals that do not correspond to binary signals to be generated in a multiary signal, conversion loss occurs, and, in addition, if there is even one error in the p-number of multiary signals, the to-be-restored n-number of binary signals will be completely different, the bit error rate will deteriorate excessively, and what is called error propagation will occur.

In contrast to this, the present invention, by comprising the constitution described hereinabove, makes it possible to implement a binary-input/ternary-output error correction code for which error propagation does not occur and there is no conversion loss.

CLAIMS

1. A digital communication method, characterized in that a binary digital information signal is converted to a ternary signal and encoded, the phase of a carrier wave is changed in response to the encoded ternary signal, and the three-phase modulated signal is transmitted.

2. A digital communication method, characterized in that information related to a ternary signal is detected by phase demodulating a phase-modulated signal, and binary digital information is obtained by carrying out decoding using the information related to the ternary signal obtained by the phase demodulation.

3. A digital communication device, characterized in comprising:

encoding means for converting binary digital information to a ternary signal; and

three-phase modulating means for changing the phase of a carrier wave in response to a ternary signal outputted from the encoding means.

4. A digital communication device, characterized in comprising:

phase demodulating means for detecting information related to a ternary signal from a phase modulated signal; and

decoding means for determining binary digital information using information related to a ternary signal outputted from the phase demodulating means.

5. The digital communication device according to Claim 3, characterized in that said encoding means comprises ternary signal encoding means which comprises:

delaying means for delaying binary digital information; and

means for carrying out an operation over a Galois field GF(3) on a signal outputted from the delaying means.

6. The digital communication device according to Claim 3, characterized in that said encoding means comprises:

means for generating, from binary digital information, an error correction code prescribed over a Galois field GF(3); and

three-phase modulating means for changing the phase of a carrier wave in response to a symbol of said error correction code.

7. The digital communication device according to Claim 3, characterized in that said three-phase modulating means comprises means for generating, in response to a ternary signal outputted from said encoding means, a constant envelope modulated wave having signal

points, the phases of which differ relatively by 2p/3 each.

8. The digital communication device according to Claim 7, characterized in that said constant envelope modulated wave generating means generates, in response to two temporally consecutive symbols, a constant envelope modulated wave, the carrier wave phases of which are either the same or differ relatively by 2p/3.

9. A constant envelope three-phase modulator, characterized in comprising:

means for delaying or storing a ternary signal;

response waveform storing means for outputting a quadrature component and an in-phase component corresponding to a transition locus of a carrier wave phase in accordance with patterns of a plurality of temporally consecutive ternary signals; and

means for orthogonally modulating a carrier wave using a quadrature component and an in-phase component outputted from the response waveform storing means.

10. The digital communication device according to Claim 7 or Claim 8, characterized in that said constant envelope modulated wave generating means is a constant envelope three-phase modulator comprising:

means for delaying or storing a ternary signal;

response waveform storing means for outputting a quadrature component and an in-phase component corresponding to a transition locus of a carrier wave phase in accordance with patterns of a plurality of temporally consecutive ternary signals; and

means for orthogonally modulating a carrier wave using a quadrature component and an in-phase component outputted from the response waveform storing means.

11. A ternary signal encoder, characterized in comprising:

an even number of delaying means for delaying binary digital information; and

means for carrying out an operation over a Galois field GF(3) on a signal outputted from the delaying means and an input signal,

the ternary signal encoder using at least the input signal and final delaying means in an operation over the Galois field GF(3).

12. The digital communication device according to any of Claim 3, Claim 5 or Claim 6, characterized in that said encoding means comprises:

an even number of delaying means for delaying binary digital information; and

means for carrying out an operation over a Galois field GF(3) on a signal outputted from the delaying means and an input signal,

the digital communication device being a ternary signal encoder which uses at least the input signal and final delaying means in an operation over the Galois field GF(3).

13. A convolutional encoder, characterized in that a generating function generates, relative to a binary input signal, a convolutional code prescribed by either

$g(D) = 1 + 2D + D^2 + D^4 + D^5 + D^6$

or

$g(D) = 2 + D + 2D^2 + 2D^4 + 2D^5 + 2D^6$.

14. The digital communication device according to any of Claim 3, Claim 5 or Claim 6, characterized in that said three-phase modulating means is a convolutional encoder in which a generating function generates, relative to a binary input signal, a convolutional code prescribed by either

$g(D) = 1 + 2D + D^2 + D^4 + D^5 + D^6$

or

$g(D) = 2 + D + 2D^2 + 2D^4 + 2D^5 + 2D^6$.

15. A digital storage device, characterized in comprising:

means for generating, from binary digital information, an error correction code prescribed over a Galois field GF(3); and

three-phase modulating means for changing the phase of a carrier wave in response to a symbol of said error correction code.

16. A digital storage device, characterized in comprising a constant envelope three-phase modulator, which comprises:

means for delaying or storing a ternary signal;

response waveform storing means for outputting a quadrature component and an in-phase component corresponding to a transition locus of a carrier wave phase in accordance with patterns of a plurality of temporally consecutive ternary signals; and

means for orthogonally modulating a carrier wave using a quadrature component and an in-phase component outputted from the response waveform storing means.

17. A digital storage device, characterized in comprising a ternary signal encoder, which comprises an even number of delaying means for delaying binary digital information; and means for carrying out an operation over a Galois field GF(3) on a signal outputted from the delaying means and an input signal, and uses at least the

input signal and final delaying means in an operation over the Galois field GF(3).

18. A digital storage device, characterized in comprising a convolutional encoder in which a generating function generates, relative to a binary input signal, a convolutional code prescribed by either

$g(D) = 1 + 2D + D^2 + D^4 + D^5 + D^6$

or

$g(D) = 2 + D + 2D^2 + 2D^4 + 2D^5 + 2D^6$.